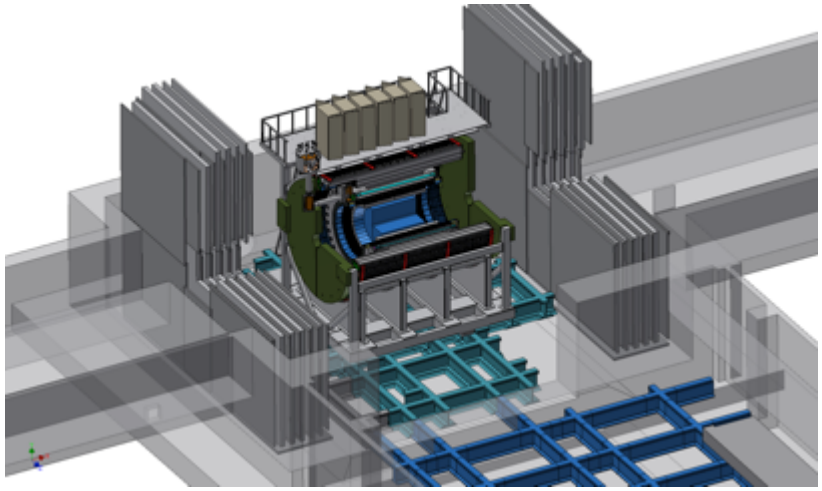
sPHENIX Installation



Director's Cost and Schedule Review
November 9-10, 2015
Don Lynch

Specifications/Requirements: sPHENIX Integration and Installation

- IR & AH Floor Loading Limits: 4000 psi, max
- Positional precision: 0.5 mm,
  Angular precision: 10 milliradian (roll, pitch and yaw)
- Installation to be accomplished in the Assembly Hall (40 ton and 5 ton overhead cranes)
- Assembly to be prepared for magnet mapping in Interaction Region (IR) after Outer HCal is installed, then returned to Assembly Hall to complete detector installations.
- Overall size requirements The complete sPHENIX assembly, including magnet valve box stack and all electronics racks, must fit through the sPHENIX sill on the existing sPHENIX rail system

WEIGHT Estimates

Inner Hcal	64,000 lb, 32 ton (Calc) (2000 lb/ module)
Outer HCal	854,000 lb, 427 ton (Calc) (27,000 lb /module)
EMCal (with mounting)	61,000 lb, 31 ton (Calc) (950 lb/module)
Inner HCal Assy Rings	1650 lb, 1 ton (total) (Calc)
Inner to Outer load transfer rings	6400 lb, 3.5 ton (total) (Calc)
Flux return end caps	226,000 lb 113 ton (Calc)
Magnet + stack wt	42,000 lb 21 ton (measured+stack estimate)
Total Detector load on Central Pedestal (CP)	1,255,000 lb 628 tons
CP weight without magnet and detectors	250,000 lb 125 tons (rough estimate)

Installation Design Drivers

Installation Design Drivers:

- Subsystem Design
- Existing Infrastructure (shield wall opening, Crane coverage and limits, rail layout)
- Access for repair, maintenance, upgrade
- Safety

sPHENIX Assembly and InstallaTION Tooling and Fixtures

We have identified all of our significant tooling needs:

- **Central Pedestal (CP)**: (standard lifting tools for CP base and rollers, cradle, support posts, bridge, access stairs), alignment tools for rollers and cradle.
- **Outer HCal**: module holding fixture (4), indexed lifting/installation fixture, alignment tools, temporary inner & outer support assembly fixtures
- **Inner HCal**: module holding fixture (4), module lifting fixture, assembly indexed/rotating fixture and insertion beam and insertion beam lifting fixture, alignment tools
- **EMCal:** module handling fixture (8), rail alignment tool, indexed lifting/installation fixture
- **Tracking**: Handling fixture (2), alignment tool, installation tool
- **SC Magnet**: Lifting fixture (spreader bar), alignment tool, stack handling/lifting tool
- **Infrastructure**: beampipe alignment tools/fixtures, bakeout tools/fixtures

Prior to Assembly

- Pre-requisites ready to begin assembly
  - Decommissioning complete
  - temporary beampipe in place
  - shield wall base in place
  - Assembly Hall prepped for sPHENIX Installation
  - Assembly and Infrastructure design and safety reviews and approvals complete
  - Assembly and Infrastructure work planning, permits on schedule to be completed and approved as required
  - Subsystem modules on schedule to be ready for installation as required

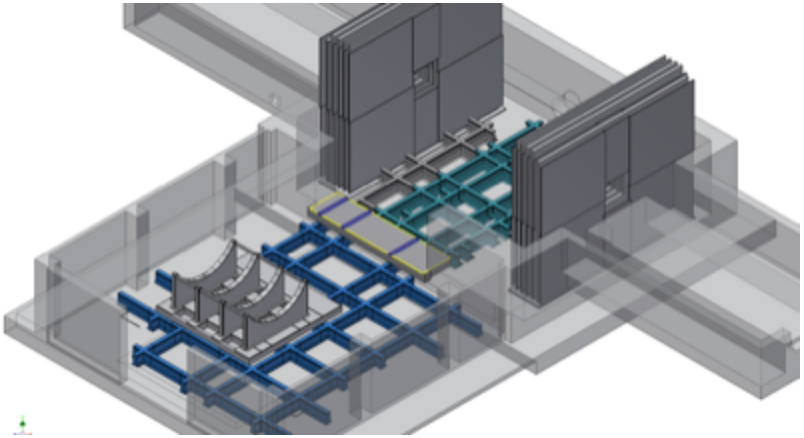
Installation Cost and Schedule Drivers

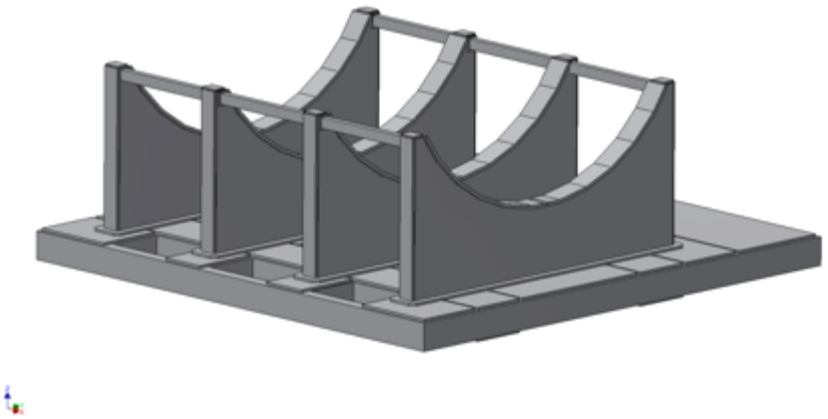
- **Major Cost Drivers** (Does not include detector sections and equipment produced as part of detector subsystems [e.g. handling fixtures])
  - Assembly, holding and lifting fixtures particularly the Outer HCal indexed lifting fixture, the Inner HCal assembly and installation fixtures, and the EMCal indexed lifting fixture
  - Alignment/ survey fixtures
  - Scaffolding and temporary HCal internal support structures
  - (Note: cost of carriage and structural support integration components is in the infrastructure subsystem
  - Technician Labor

- **Major Schedule Drivers**
  - Infrastructure completion (which in turn is dependent on decommissioning completion)
  - Delivery of carriage components and internal structural support components
  - Delivery of Outer HCal sectors, Magnet, Inner HCal, EMCal and Tracker sections
  - Magnet mapping
  - Commissioning

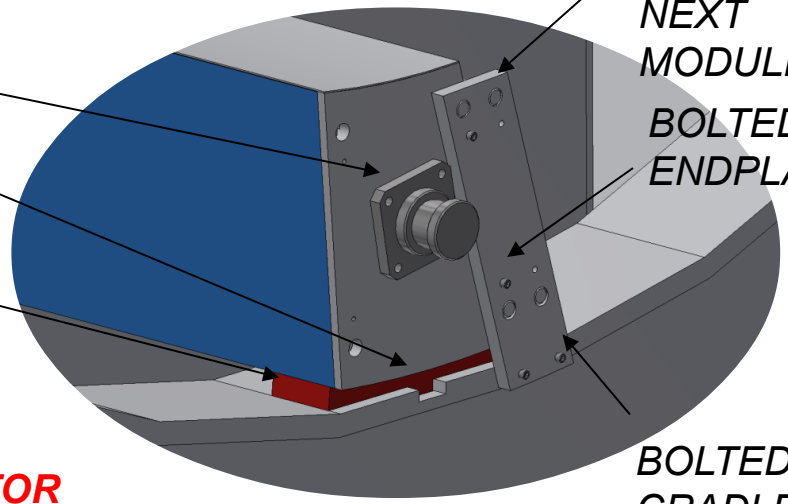
Install the Central Pedestal (CP) Base

- Gather and stage CP Base components (base platform sections, Hillman Rollers, X-Y alignment details, cradle arcs)
- Assemble lower platform
- Install and position cradle arcs and cross members
- Survey cradle arcs, adjust alignment and indexing, weld in place
- Position, align and install Hillman Rollers

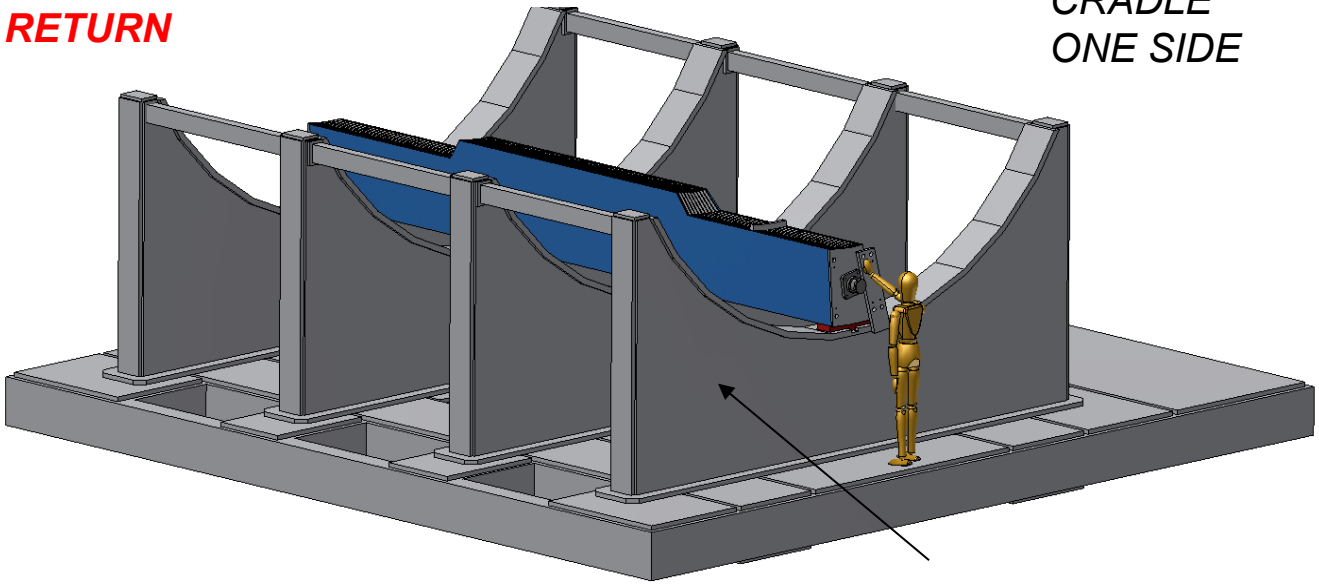




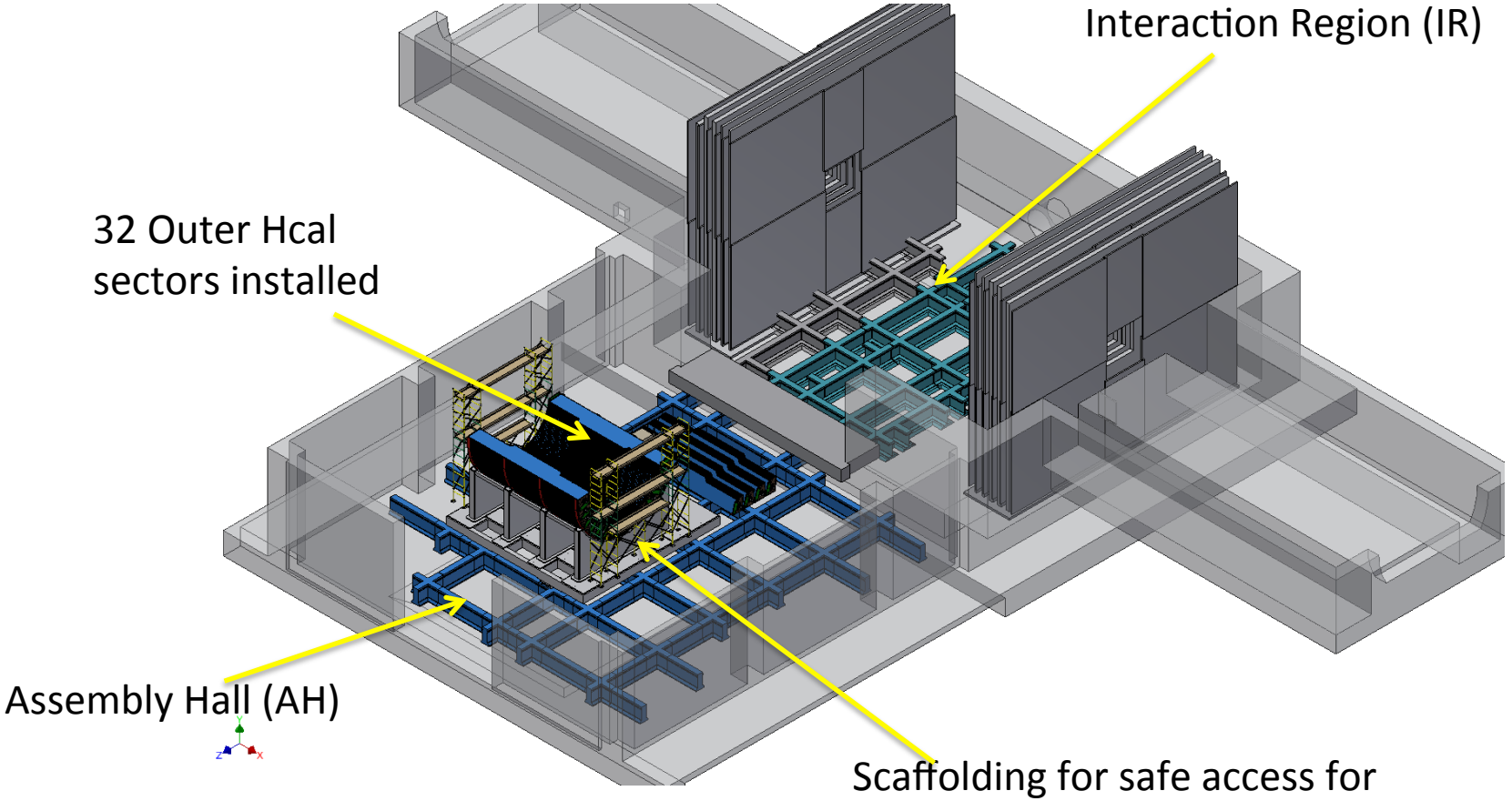
1ST HCAL MODULE INSTALLATION



OUTER HCAL SERVES AS THE SUPPORT STRUCTURE FOR THE DETECTOR AND MAGNET FLUX RETURN

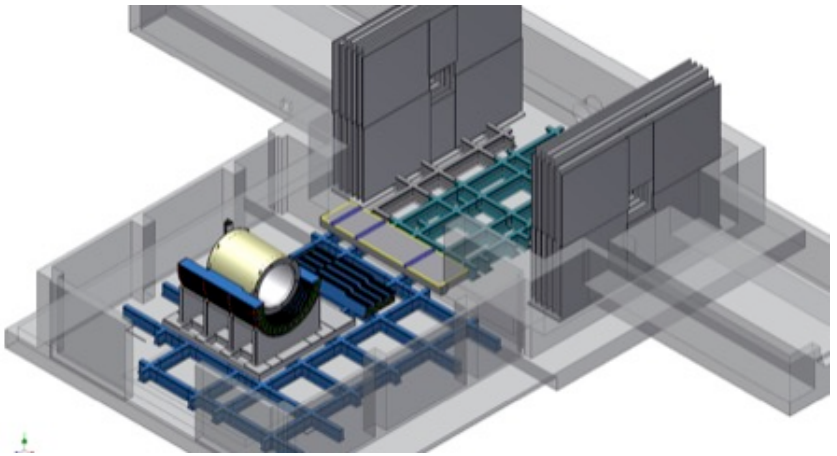


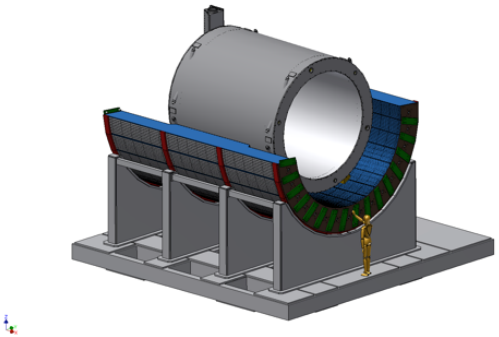
Install the Lower Half of the Outer HCal



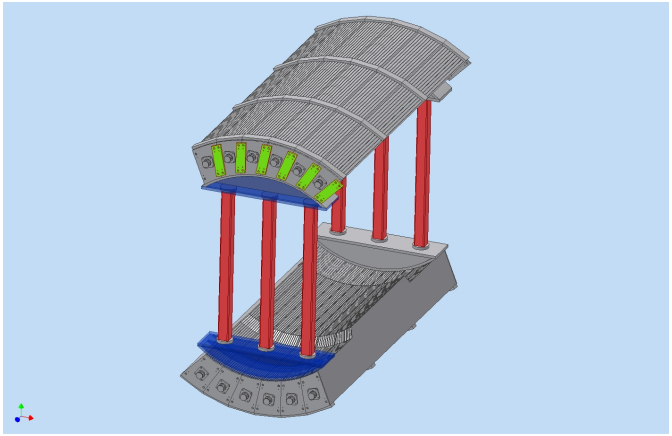
Install the Magnet

- Transport the Magnet to the AH
- Mount on the Outer HCal
- Survey into position

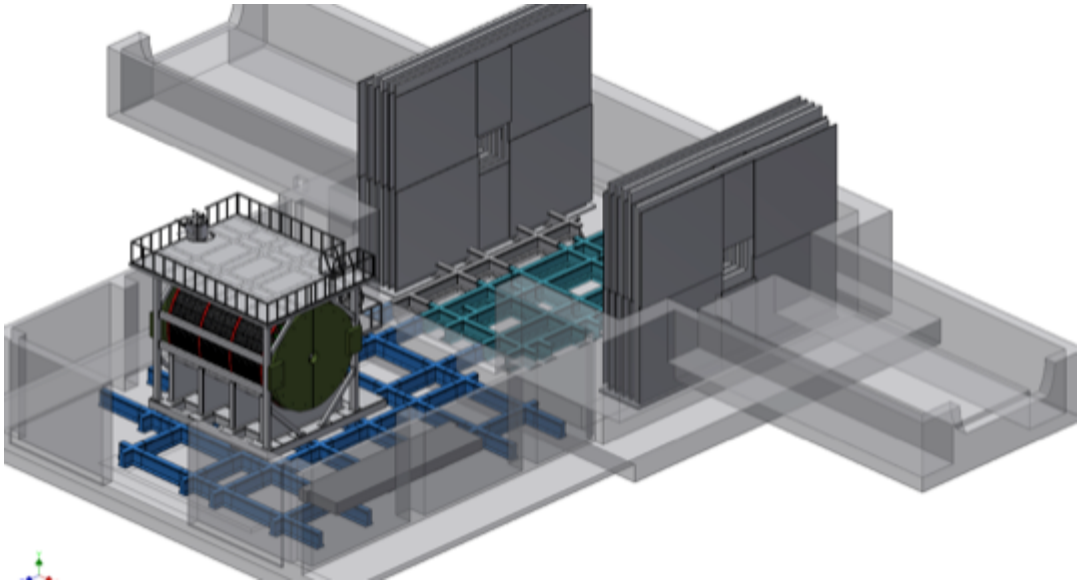


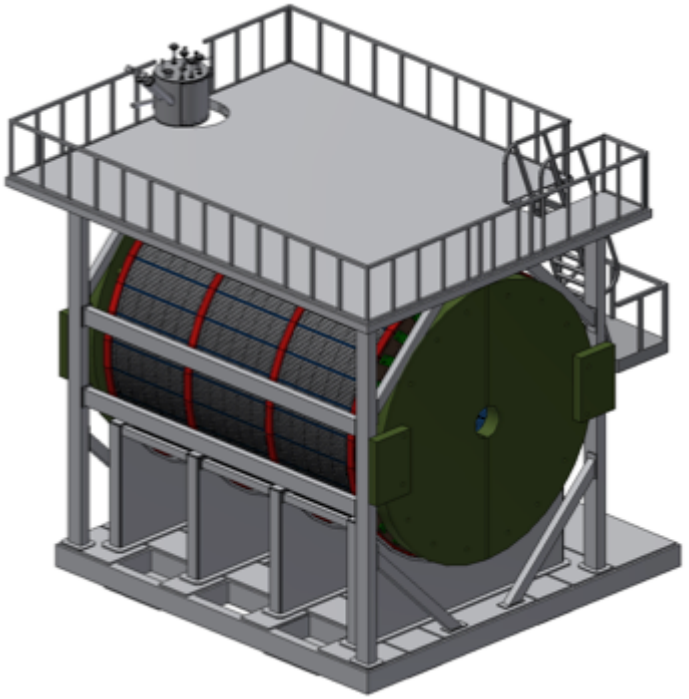


Install the rest of the Outer HCal, Upper Platform & Magnet Stack

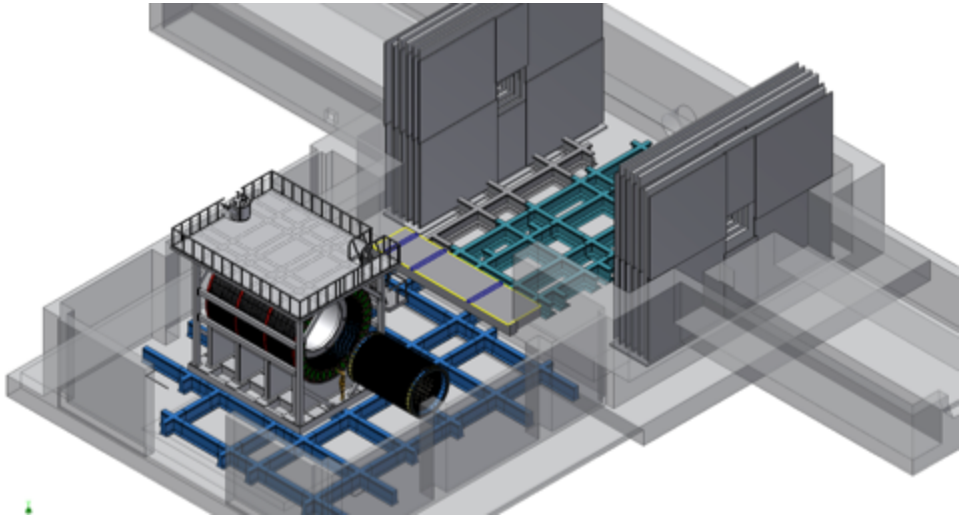


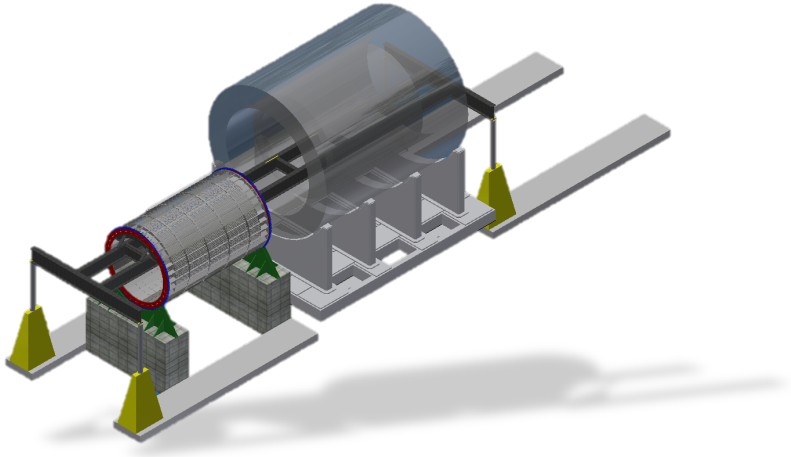
- Install upper platform support columns and bracing
- Install SC magnet Stack
- Install Flux return End Caps
- Into IR for Magnet mapping/Test then Back to AH



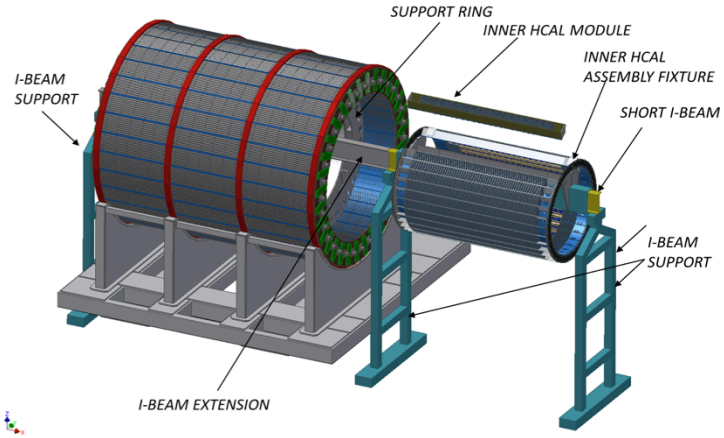


Inner HCal



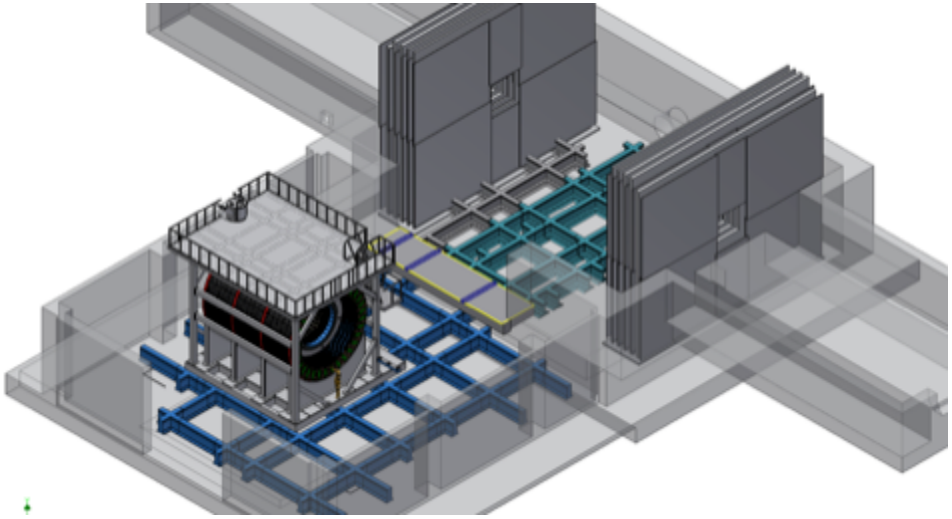


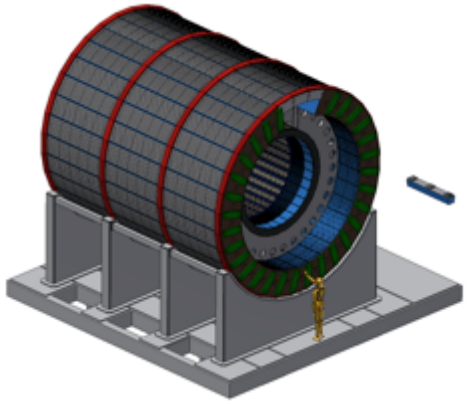
- Transport Inner HCal completed modules to AH
- Test to make sure electronics are intact after transport
- Assemble Inner HCal in rotating assembly fixture 1 module at a time
- Final adjustments and lock
- Install Inner HCal mounting supports
- Install beam extension
- Install the full Inner Hcal, align and attach to the Inner HCal mounting supports.
- Install patch panels, cables, and route to racks
- Test all connections

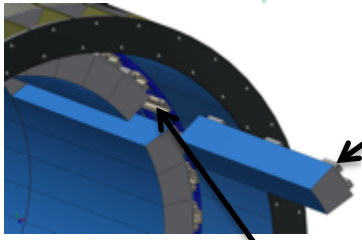


EMCal

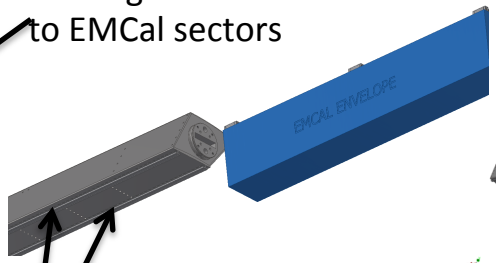
- Transport modules to AH
- Test to make sure electronics are intact after transport.
- One by one Insert and align the 32 south EMCal modules using the indexed insertion tool.
- Repeat for north side
- Make final alignment adjustments and secure and lock all modules in place.
- Install patch panels, cables, services and route to racks
- Test all connections

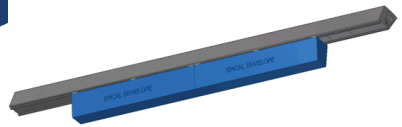






Bearing blocks attached to EMCal sectors

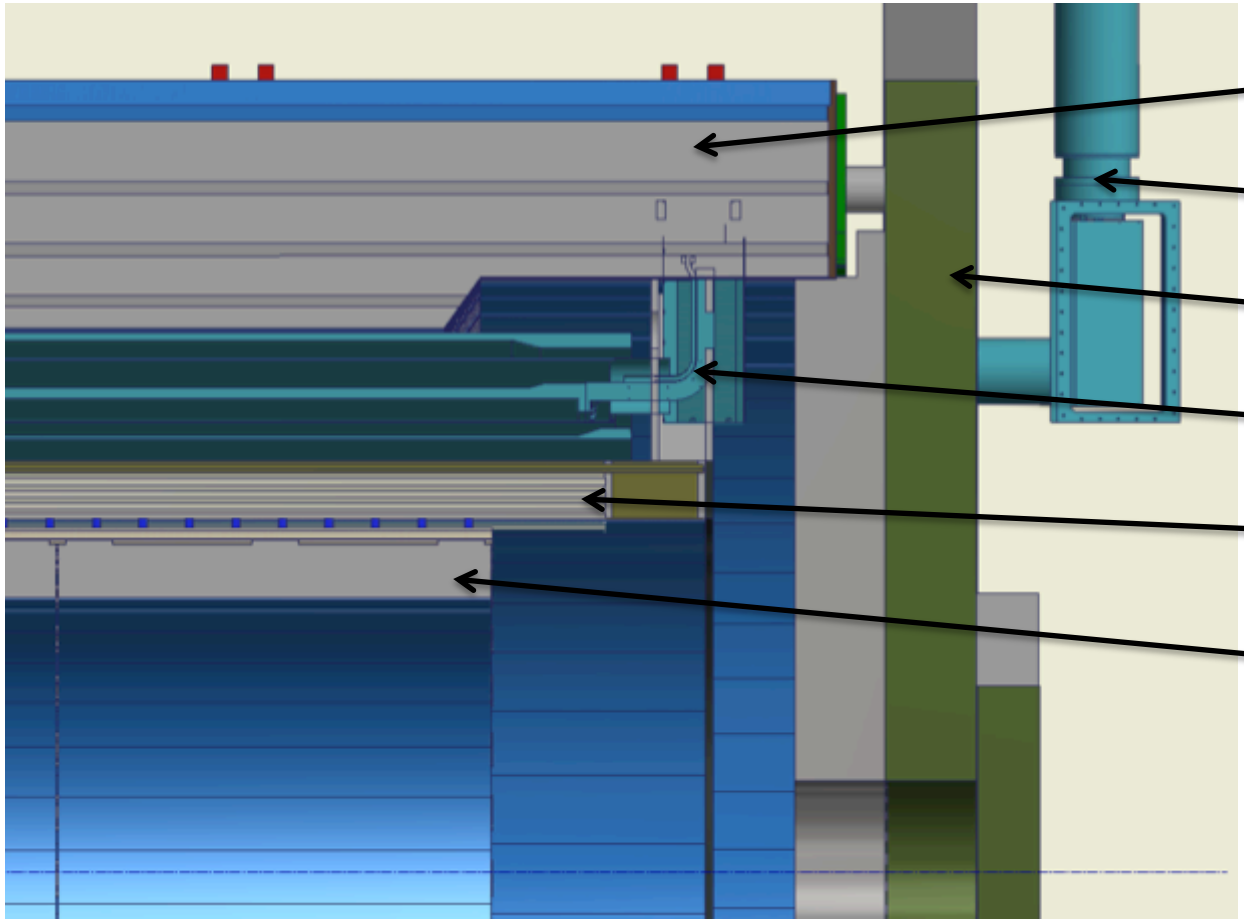


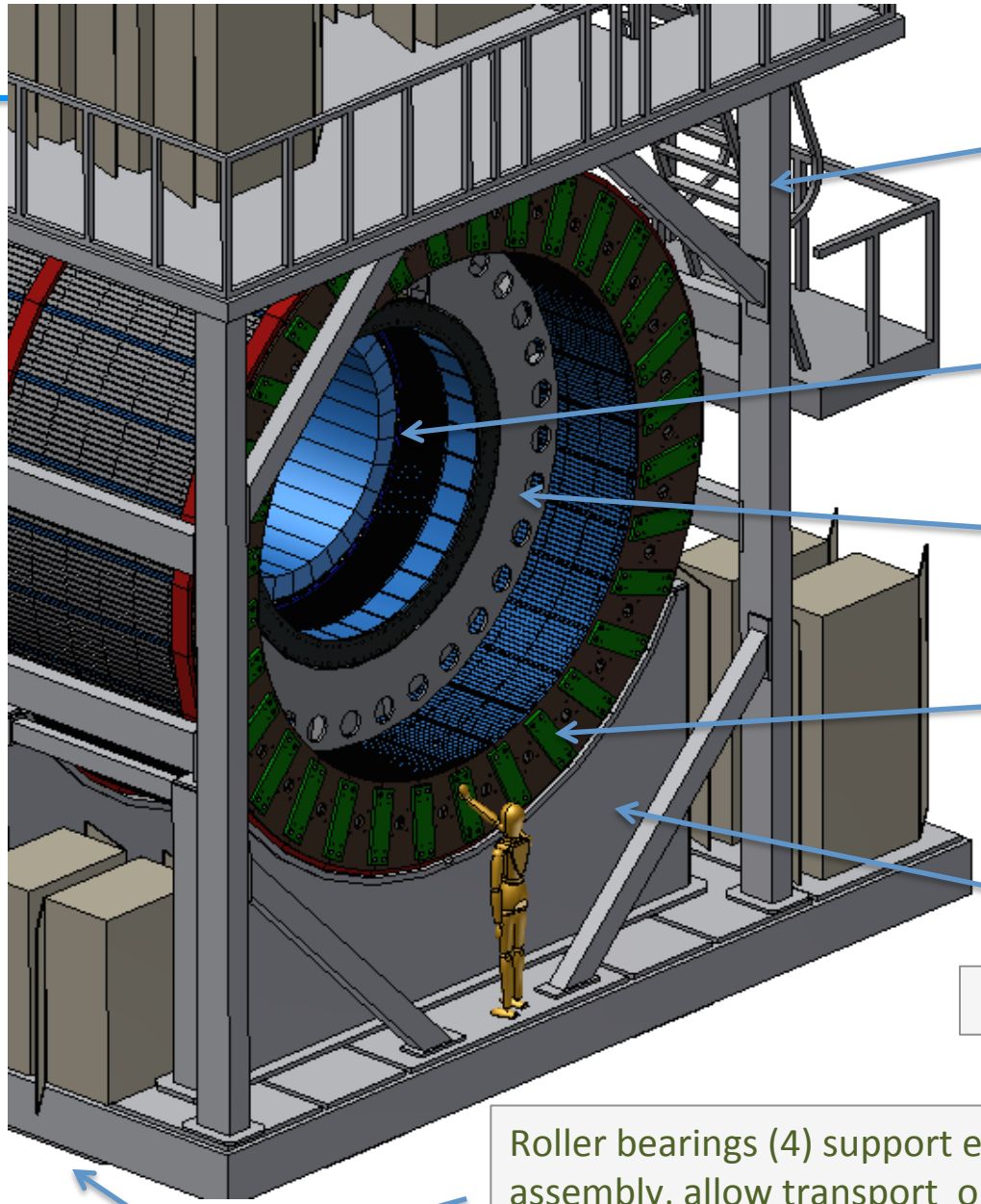


Rails attached to Inner HCal Sectors

2 EMCal sectors (north and south) attached to each Inner HCal Sector

Detector Cross Section





Columns supporting mid and upper platforms and flux return pole tips (not shown)

Rails supporting EMCal sectors from Inner HCal sectors

Inner HCal to Outer HCal support rings

Splice Plates Join Outer HCal sectors

Cradles (4) support Outer HCal

Not shown: Magnet mounting feet (12)

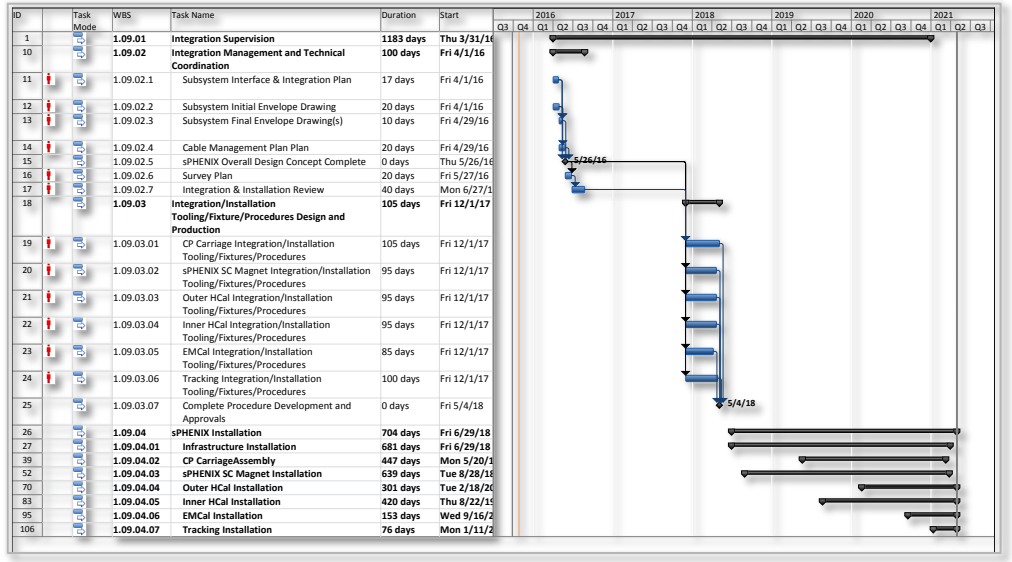
Roller bearings (4) support entire sPHENIX assembly, allow transport on sPHENIX rail system

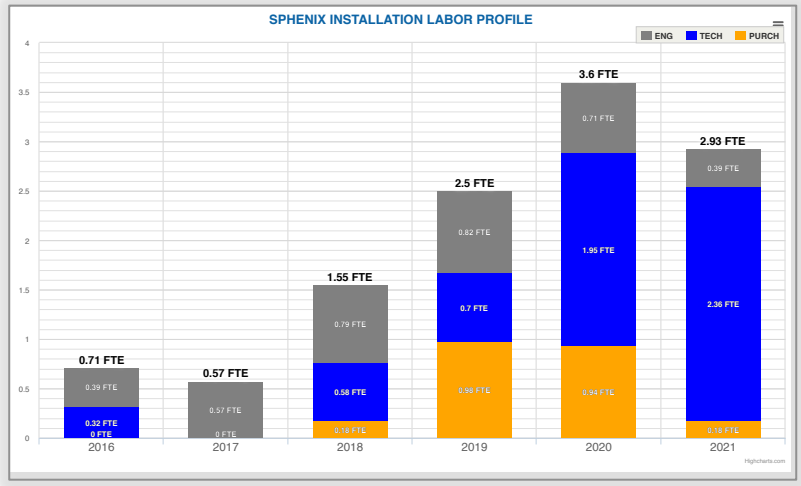
Installation Schedule and resource Requirements

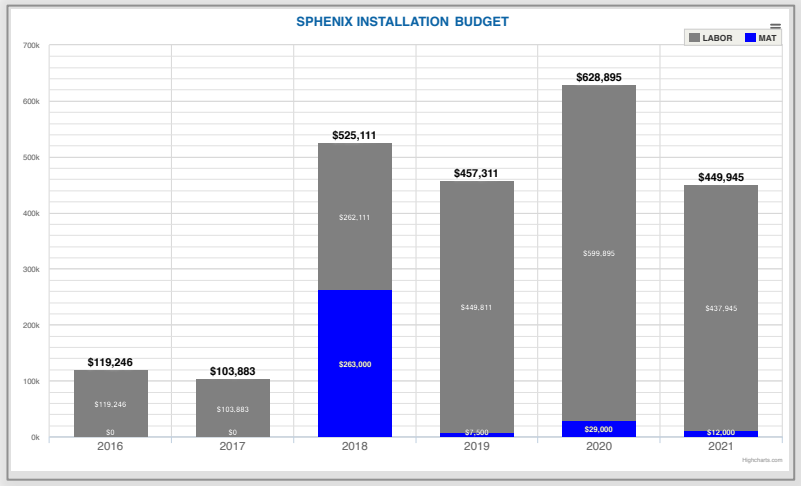
Key Dates

8/22/17	Decommissioning of PHENIX complete
6/29/18	Funds available to procure base components
5/20/19	Base components ready for assembly
7/20/20	Magnetic measurements/mapping (adds 4 mos)
3/4/21	Installation, sPHENIX complete ready for commissioning

ID	Task Mode	WBS	Task Name	Duration	Start
1		**1.09.01**	**Integration Supervision**	**1183 days**	**Thu 3/31/16**
10		**1.09.02**	**Integration Management and Technical Coordination**	**100 days**	**Fri 4/1/16**
11		1.09.02.1	Subsystem Interface & Integration Plan	17 days	Fri 4/1/16
12		1.09.02.2	Subsystem Initial Envelope Drawing	20 days	Fri 4/1/16
13		1.09.02.3	Subsystem Final Envelope Drawing(s)	10 days	Fri 4/29/16
14		1.09.02.4	Cable Management Plan Plan	20 days	Fri 4/29/16
15		1.09.02.5	sPHENIX Overall Design Concept Complete	0 days	Thu 5/26/16
16		1.09.02.6	Survey Plan	20 days	Fri 5/27/16
17		1.09.02.7	Integration & Installation Review	40 days	Mon 6/27/1
18		**1.09.03**	**Integration/Installation Tooling/Fixture/Procedures Design and Production**	**105 days**	**Fri 12/1/17**
19		1.09.03.01	CP Carriage Integration/Installation Tooling/Fixtures/Procedures	105 days	Fri 12/1/17
20		1.09.03.02	sPHENIX SC Magnet Integration/Installation Tooling/Fixtures/Procedures	95 days	Fri 12/1/17
21		1.09.03.03	Outer HCal Integration/Installation Tooling/Fixtures/Procedures	95 days	Fri 12/1/17
22		1.09.03.04	Inner HCal Integration/Installation Tooling/Fixtures/Procedures	95 days	Fri 12/1/17
23		1.09.03.05	EMCal Integration/Installation Tooling/Fixtures/Procedures	85 days	Fri 12/1/17
24		1.09.03.06	Tracking Integration/Installation Tooling/Fixtures/Procedures	100 days	Fri 12/1/17
25		1.09.03.07	Complete Procedure Development and Approvals	0 days	Fri 5/4/18
26		**1.09.04**	**sPHENIX Installation**	**704 days**	**Fri 6/29/18**
27		**1.09.04.01**	**Infrastructure Installation**	**681 days**	**Fri 6/29/18**
39		**1.09.04.02**	**CP CarriageAssembly**	**447 days**	**Mon 5/20/1**
52		**1.09.04.03**	**sPHENIX SC Magnet Installation**	**639 days**	**Tue 8/28/1**
70		**1.09.04.04**	**Outer HCal Installation**	**301 days**	**Tue 2/18/2**
83		**1.09.04.05**	**Inner HCal Installation**	**420 days**	**Thu 8/22/1**
95		**1.09.04.06**	**EMCal Installation**	**153 days**	**Wed 9/16/2**
106		**1.09.04.07**	**Tracking Installation**	**76 days**	**Mon 1/11/2**







Installation
Issues and Concerns

- **Installation**
  - Alignment tolerances for individual detector subsystems – Is precision specification appropriate
  - Magnet mounting & alignment
    - intrinsic to magnet: adapting SLAC mounting feet to sPHENIX Outer Hcal
    - Field calculation to determine acceptable tolerances
  - Magnet Mapping: do we need Inner HCal installed?
  - Details of Inner HCal installation fixture design
    - Operation (rotating locking clutch, safety considerations)
    - Design of beam for installing complete
  - EMCal alignment provisions
  - Tracker assembly design details
    - What are alignment requirements?, Install before or after beampipe?, Install as a unit or in sections?

Back Up Materials

Infrastructure Schedule and Resource Requirements

Key Dates

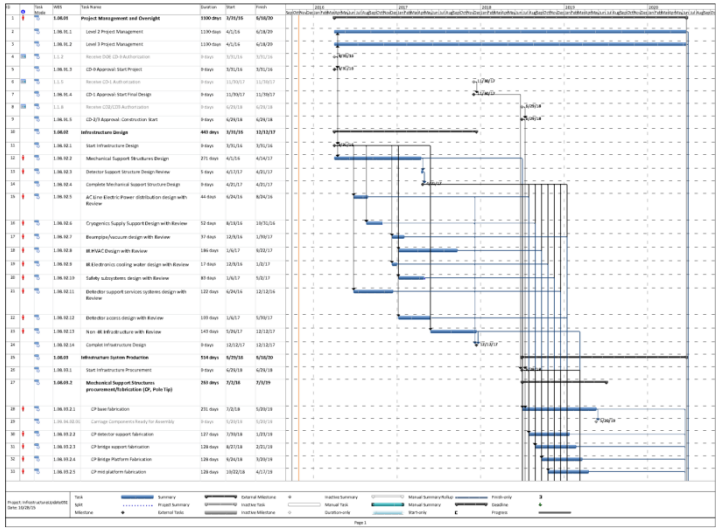
04/2016 Start Cradle and Baseplate Design

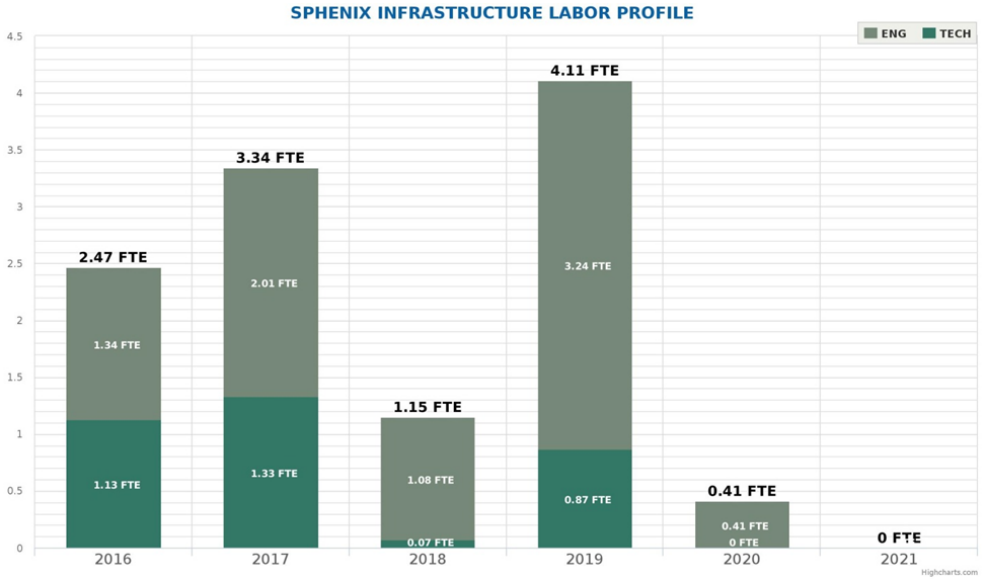
04/2017 Cradle and Baseplate Design Complete

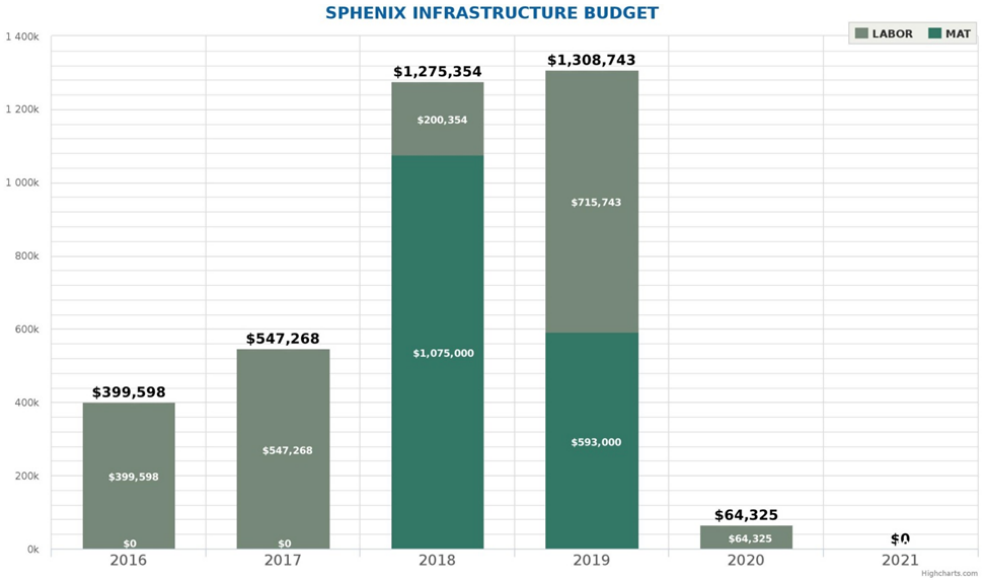
07/2018 Start Central Pedestal Fabrication

05/2019 Complete Central Pedestal Fabrication

Infrastructure Schedule



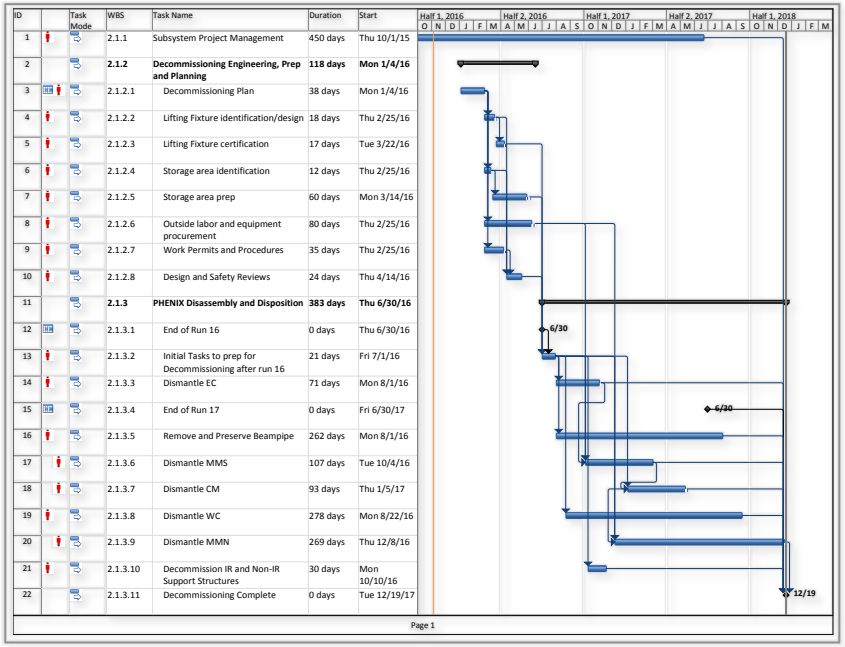




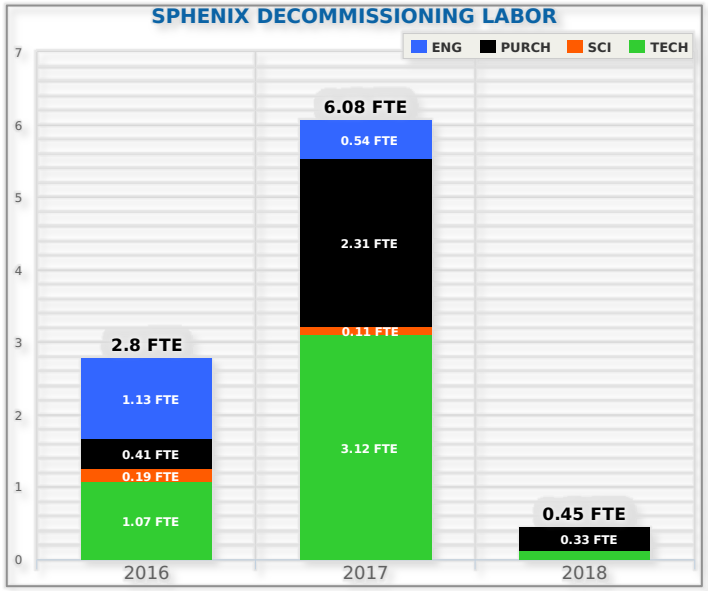
Decommissioning Schedule and Resource Requirements

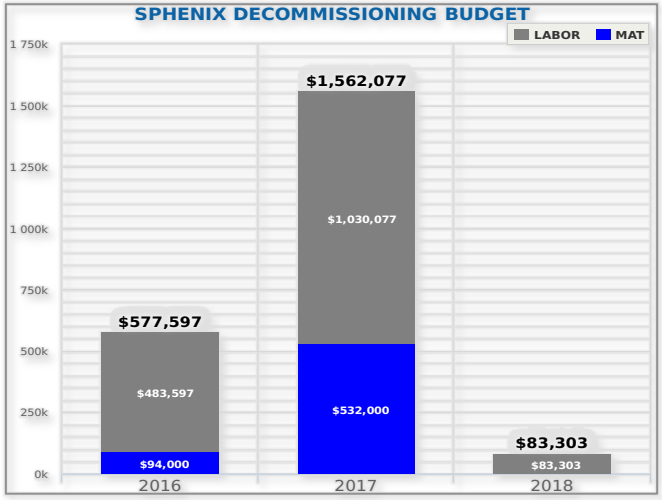
Key Schedule Dates

4/3/16	Approval to Decommission
6/30/16	End of Run 16/ begin Decommissioning
1/1/17	run 17 Begins, IR is closed for run
6/30/17	Run 17 ends
12/19/17	Decommissioning complete



ID	Task Mode	WBS	Task Name	Duration	Start
1		2.1.1	Subsystem Project Management	450 days	Thu 10/1/15
2		**2.1.2**	**Decommissioning Engineering, Prep and Planning**	**118 days**	**Mon 1/4/16**
3		2.1.2.1	Decommissioning Plan	38 days	Mon 1/4/16
4		2.1.2.2	Lifting Fixture identification/design	18 days	Thu 2/25/16
5		2.1.2.3	Lifting Fixture certification	17 days	Tue 3/22/16
6		2.1.2.4	Storage area identification	12 days	Thu 2/25/16
7		2.1.2.5	Storage area prep	60 days	Mon 3/14/16
8		2.1.2.6	Outside labor and equipment procurement	80 days	Thu 2/25/16
9		2.1.2.7	Work Permits and Procedures	35 days	Thu 2/25/16
10		2.1.2.8	Design and Safety Reviews	24 days	Thu 4/14/16
11		**2.1.3**	**PHENIX Disassembly and Disposition**	**383 days**	**Thu 6/30/16**
12		2.1.3.1	End of Run 16	0 days	Thu 6/30/16
13		2.1.3.2	Initial Tasks to prep for Decommissioning after run 16	21 days	Fri 7/1/16
14		2.1.3.3	Dismantle EC	71 days	Mon 8/1/16
15		2.1.3.4	End of Run 17	0 days	Fri 6/30/17
16		2.1.3.5	Remove and Preserve Beampipe	262 days	Mon 8/1/16
17		2.1.3.6	Dismantle MMS	107 days	Tue 10/4/16
18		2.1.3.7	Dismantle CM	93 days	Thu 1/5/17
19		2.1.3.8	Dismantle WC	278 days	Mon 8/22/16
20		2.1.3.9	Dismantle MMN	269 days	Thu 12/8/16
21		2.1.3.10	Decommission IR and Non-IR Support Structures	30 days	Mon 10/10/16
22		2.1.3.11	Decommissioning Complete	0 days	Tue 12/19/17





Magnet Schedule and Resource Requirements

Key Dates

04/2015 Preliminary Acceptance Test (Completed)

01/2016 Low Field Test

12/2016 High Field Test

04/2016 Start Magnet Design

03/2018 Power Supply, Q/D, Cryo Design Complete

07/2018 Start Material Purchase and Fabrication

07/2019 Coil Ready to Install

03/2020 Pre-Op Lab Safety Review

Magnet Schedule